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Department of Information Technology

Introduction to Mobile Communication

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Mobile Telecommunication System

UNIT II MOBILE TELECOMMUNICATION SYSTEM 9

GSM – Architecture – Protocols – Connection Establishment – Frequency Allocation – Routing – Mobility Management – Security –GPRS- UMTS- Architecture

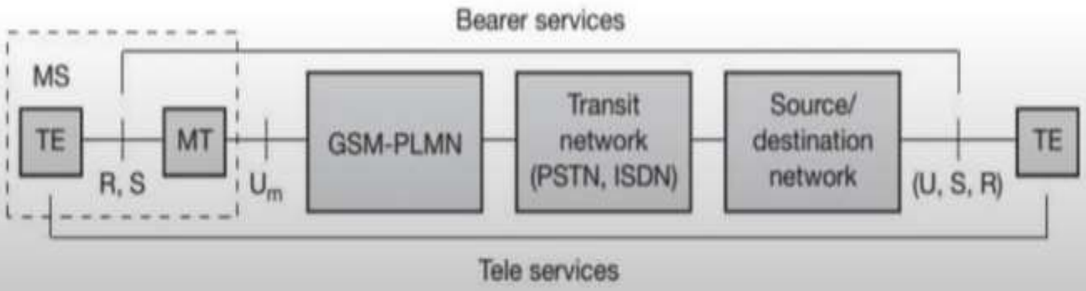
GSM -Introduction

- GSM is the most successful digital mobile telecommunication system in the world today.
- The **group special mobile** (GSM) was founded in 1982.
- This system was soon named the **global system for mobile communications** (GSM), with the specification process lying in the hands of **ETSI**.
- The primary goal of GSM was to provide a mobile phone system that allows users to **roam** throughout world and provides **voice services** compatible to **ISDN**(Integrated services digital network) and other **PSTN**(Public switched telephone network) systems.
- GSM offers several types of connections : voice connections, data connections and SMS. Also provide multi-service options.

GSM -Introduction

Mobile services

- Services make a network interesting for customers. GSM has defined three different categories of services:
  - Bearer Services
  - Tele Services
  - Supplementary services



Bearer and tele services reference model

GSM -Introduction

- A mobile station MS is connected to the GSM public land mobile network (PLMN)via the Um interface. (GSM-PLMN is the infrastructure needed for the GSM network.)
- This network is connected to transit networks, e.g., integrated services digital network (ISDN) or traditional public switched telephone network (PSTN).
- There might be an additional network, the source/destination network, before another terminal TE is connected.
- Bearer services now comprise all services that enable the transparent transmission of data between the interfaces to the network, i.e., S in case of the mobile station, and a similar interface for the other terminal (e.g., S_0 for ISDN terminals).
- Interfaces like **U, S,** and **R** in case of ISDN have not been defined for all networks, so it depends on the specific network which interface is used as a reference for the transparent transmission of data.
- Within the **mobile station** MS, the **mobile termination** (MT) performs all network specific tasks (TDMA, FDMA, coding etc.) and offers an interface for data transmission (S) to the **terminal** TE which can then be network independent.

GSM -Introduction

1.Bearer services

- GSM specifies different mechanisms for data transmission, the original GSM allowing for data rates of up to 9600 bit/s for non-voice services.
- Bearer services permit **transparent** and **non-transparent**, **synchronous** or **asynchronous** data transmission.
- **Transparent bearer services** only use the functions of the **physical layer** (layer 1) to transmit data.
- Data transmission has a constant delay and throughput if no transmission errors occur.
- The only mechanism to increase transmission **quality** is the use of **forward error correction** (FEC), which codes redundancy into the data stream and helps to reconstruct the original data in case of transmission errors.
- Transparent bearer services **do not try to recover** lost data in case of, for example, shadowing or interruptions due to handover.

GSM -Introduction

- **Non-transparent bearer services** use protocols of **layers two and three** to implement error correction and flow control.
- These services use the transparent bearer services, adding a radio link protocol (RLP).
- This protocol comprises mechanisms of **high-level data link control** (HDLC), and special selective-reject mechanisms to trigger retransmission of erroneous data.
- Using transparent and non-transparent services, GSM specifies several bearer services for interworking with PSTN, ISDN, and packet switched public data networks (PSPDN) like X.25, which is available worldwide.
- Data transmission can be **full-duplex, synchronous** with data rates of 1.2, 2.4, 4.8, and 9.6 kbit/s or **full-duplex, asynchronous** from 300 to 9,600 bit/s.

GSM -Introduction

2. Tele services

- GSM mainly focuses on **voice-oriented** tele services.
- These comprise **encrypted voice transmission**, **message services**, and basic **data communication** with terminals as known from the PSTN or ISDN (e.g., fax).
- However, as the main service is telephony, the primary goal of GSM was the provision of **high-quality digital voice transmission**, offering at least the typical bandwidth of 3.1 kHz of analog phone systems.
- Another service offered by GSM is the **emergency number**.
- A useful service for very simple message transfer is the **short message service** (SMS), which offers transmission of messages of up to 160 characters.
- The successor of SMS, the **enhanced message service** (EMS), offers a larger message size (e.g., 760 characters, concatenating several SMS), formatted text, and the transmission of animated pictures, small images and ring tones in a standardized way.
- EMS never really took off as the **multimedia message service** (MMS) was available.
- MMS offers the transmission of larger pictures (GIF, JPG, WBMP), short video clips etc. and comes with mobile phones that integrate small cameras.
- Another non-voice tele service is **group 3 fax**, which is available worldwide.

GSM -Introduction

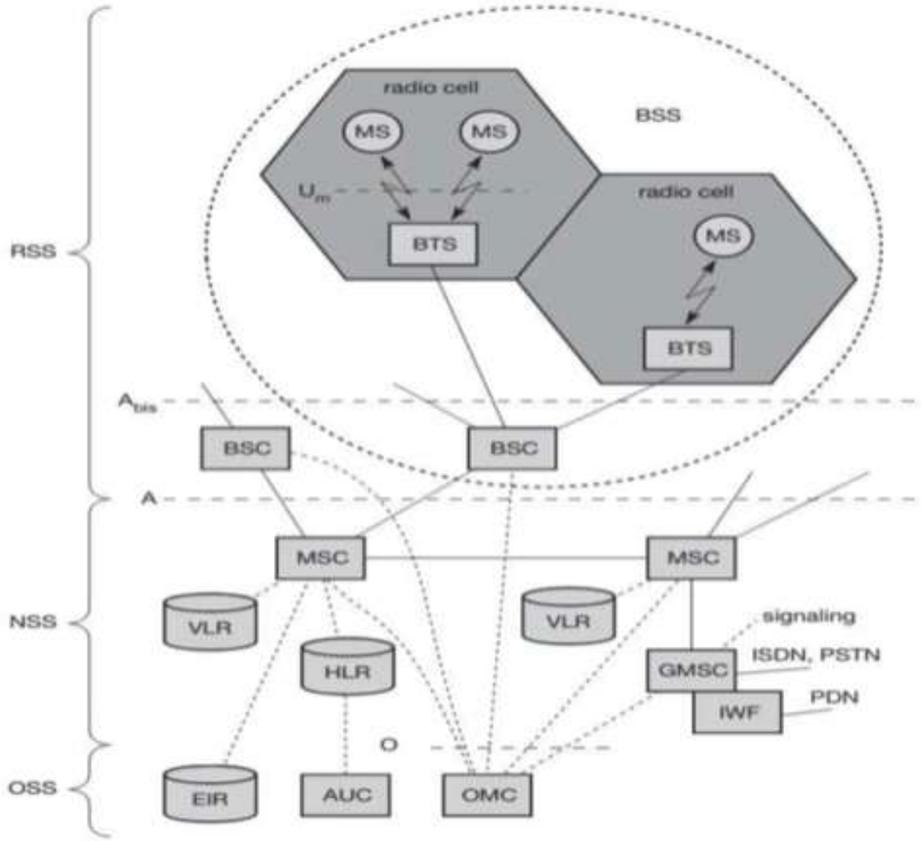
3. Supplementary services

- Supplementary services are additional services that are provided in addition to teleservices and bearer services. These services include caller identification, call forwarding, call waiting, multi-party conversations, and barring of outgoing (international) calls, among others.
- Conferencing
- Call Waiting
- Call Hold
- Call Forwarding
- Call Barring
- Number Identification
- Advice of Charge (AoC)
- Closed User Groups (CUGs)

GSM -Architecture

- As with all systems in the telecommunication area, GSM comes with a hierarchical, complex system architecture comprising many entities, interfaces, and acronyms.
- A GSM system consists of three subsystems,
  - The **radio sub system** (RSS),
  - The **network and switching subsystem** (NSS), and
  - The **operation subsystem** (OSS).
- Generally, a GSM **customer only notices** a very small fraction of the whole network - the **mobile stations** (MS) and some antenna masts of the **base transceiver stations** (BTS).

GSM -Architecture



Functional architecture of a GSM system

SIM Subscriber Icentity Module
ME Mobile Equipnent
BTS Base Transceiver Station
BSC Base Station Controller
HLR Home Location Register
VLR Visitor Location Register

MSC Mobile services Switching Center
EIR Equipment Identity Register
AuC Authentication Center

GMSC Gateway MSC
PSTN Public switched telephone network
IWF Internetworking Function

GSM -Architecture

1. Radio station subsystem

• As the name implies, the radio subsystem (RSS) comprises all radio specific entities, i.e., the **mobile stations** (MS) and the **base station subsystem** (BSS).

• Figure shows the connection between the RSS and the NSS via the **A interface** and the connection to the OSS via the **O interface.**

• Mobile station (MS) :

- The MS comprises all user equipment and software needed for communication with a GSM network.

- An MS consists of user independent hard- and software and of the subscriber identity module (SIM), which stores all user specific data that is relevant to GSM.

• While an MS can be identified via the **International Mobile Equipment Identity** (IMEI).

• A user can personalize any MS using his or her SIM, i.e., user specific mechanisms like charging and authentication are based on the SIM, not on the device itself.

• Base station subsystem (BSS) :

- A GSM network comprises many BSSs, each controlled by a base station controller (BSC).

- The BSS performs all functions necessary to maintain radio connections to an MS, coding/decoding of voice, and rate adaptation to/from the wireless network part.

- Besides a BSC, the BSS contains several BTSs.

GSM -Architecture

- **Base transceiver station (BTS) :**

- A BTS comprises all radio equipment, i.e., antennas, signal processing, amplifiers necessary for radio transmission.

- A BTS can form a radio cell or, using sectorized antennas, several cells, and is connected to MS via the **Um interface**, and to the BSC via the **Abis interface**.

- A GSM cell can measure between some 100 m and 35 km depending on the environment but also expected traffic.

- **Base station controller (BSC) :**

- The BSC basically manages the BTSs.

- It reserves radio frequencies, handles the handover from one BTS to another within the BSS, and performs paging of the MS.

- The BSC also multiplexes the radio channels onto the fixed network connections at the A interface.

GSM -Architecture

2. Network and switching subsystem

- The "heart" of the GSM system is formed by the network and switching subsystem (NSS).
- The NSS connects the wireless network with standard public networks, performs handovers between different BSSs, comprises functions for worldwide localization of users and supports charging, accounting, and roaming of users between different providers in different countries.

The NSS consists of the following switches and databases:

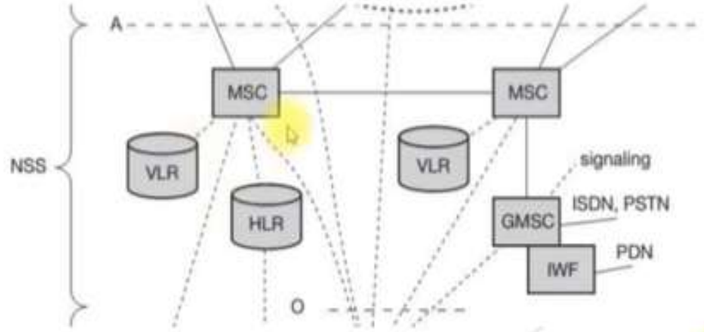
Mobile services switching center (MSC)

Home location register (HLR)

Visitor location register (VLR)

Gateway MSC (GMSC)

Interworking Functions(IWF)



GSM -Architecture

- **Mobile services switching center (MSC) :**

- MSCs are high-performance digital ISDN switches.

- They set up connections to other MSCs and to the BSCs via the A interface, and form the fixed backbone network of a GSM system.

- Typically, an MSC manages several BSCs in a geographical region.

- A **gateway MSC** (GMSC) has additional connections to other fixed networks, such as PSTN and ISDN.

- Using additional **interworking functions** (IWF), an MSC can also connect to **public data networks** (PDN) such as X.25.

- An MSC handles all signaling needed for connection setup, connection release and handover of connections to other MSCs.

- The standard signaling system No. 7 (SS7) is used for this purpose. SS7 covers all aspects of control signaling for digital networks.

- Features of SS7 are number portability, free phone/toll/collect/credit calls, call forwarding, three-way calling etc.

- An MSC also performs all functions needed for supplementary services such as call forwarding, multi-party calls, reverse charging etc.

GSM -Architecture

- **Home location register (HLR) :**

- The HLR is the most important database in a GSM system as it stores all user-relevant information.

- This comprises **static information**, such as the mobile subscriber ISDN number (MSISDN), subscribed services (e.g., call forwarding, roaming restrictions, GPRS), and the international mobile subscriber identity (IMSI).

- As soon as an MS leaves its current LA, the information in the HLR is updated.

- All these user-specific information elements only exist once for each user in a single HLR, which also supports charging and accounting.

- HLRs can manage data for several million customers and contain highly specialized data bases which must fulfill certain real-time requirements to answer requests within certain time-bounds.

GSM -Architecture

- Visitor location register (VLR) :

- The VLR associated to each MSC is a **dynamic database** which stores all important information needed for the MS users currently in the LA that is associated to the MSC (e.g., IMSI, MSISDN, HLR address).

- If a new MS comes into an LA the VLR is responsible for, it copies all relevant information for this user from the HLR.

- This hierarchy of VLR and HLR avoids frequent HLR updates and long-distance signaling of user information.

- Some VLRs in existence, are capable of managing up to one million customers.

GSM -Architecture

3. Operation subsystem

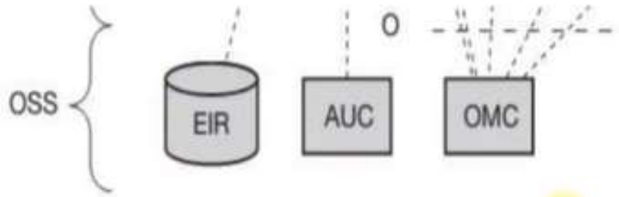
- The third part of a GSM system, the operation subsystem (OSS), contains the necessary functions for network operation and maintenance.
- The OSS possesses network entities of its own and accesses other entities via SS7 signaling.

The following entities have been defined:

Operation and maintenance center (OMC)

Authentication center (AuC)

Equipment identity register (EIR)



GSM -Architecture

- **Operation and maintenance center (OMC) :**

- The OMC monitors and controls all other network entities via the O interface (SS7 with X.25).

- Typical OMC management functions are traffic monitoring, status reports of network entities, subscriber and security management, or accounting and billing.

- **Authentication center (AuC) :**

- As the radio interface and mobile stations are particularly vulnerable, a separate AuC has been defined to protect user identity and data transmission.

- The AuC contains the algorithms for authentication as well as the keys for encryption and generates the values needed for user authentication in the HLR.

- The AuC may, in fact, be situated in a special protected part of the HLR.

- **Equipment identity register (EIR) :**

- The EIR is a database for all IMEIs, i.e., it stores all device identifications registered for this network.

- As MSs are mobile, they can be easily stolen. With a valid SIM, anyone could use the stolen MS.

- The EIR has a blacklist of stolen (or locked) devices.

- In theory an MS is useless as soon as the owner has reported a theft.

- The EIR also contains a list of valid IMEIs (white list), and a list of malfunctioning devices.

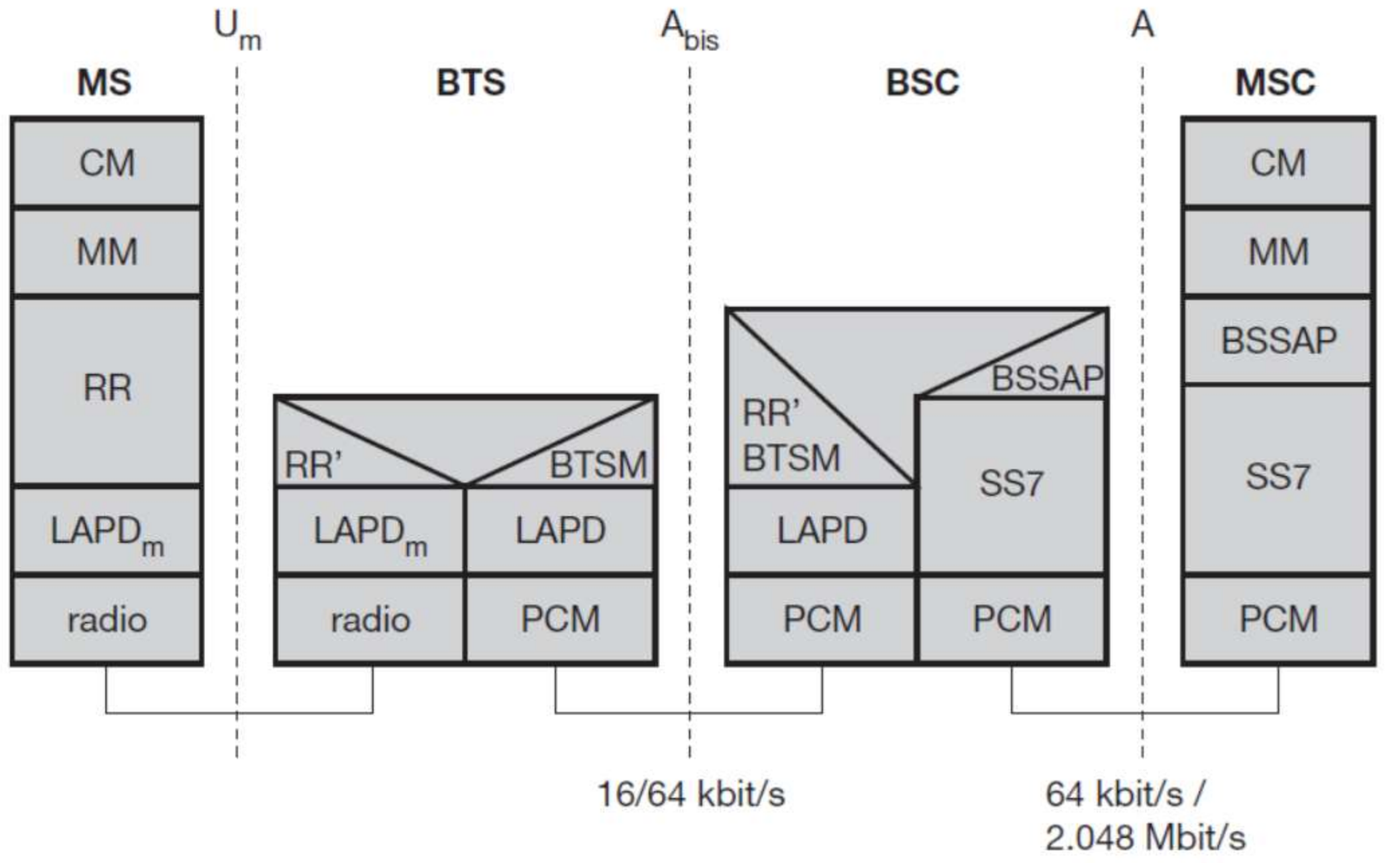
GSM -Architecture

Interfaces

1. U_m or Air Interface: It is used for Radio frequency. It uses the technique called TDMA. Um interface transmits and receive the information related to traffic and signal in between MS and BTS.
2. Abis Interface: Transmit and receive information between BTS and BSC. This interface uses Link Access Protocol(LAP).
3. A Interface: This interface is used between BSC and MSC. It manages the BSS. Call handling is done A interface. Bandwidth handling is also done by this. Connectivity is provided to use this interface is of 2mbps.
4. O Interface: This interface uses the Signaling System No. 7 (SS7) based on X.25 carrying management data to/from the RSS.

GSM -Protocols

Figure 4.7
Protocol architecture for signaling



GSM -Protocols

- The main interest lies in the Um interface, as the other interfaces occur between entities in a fixed network.
- Layer 1, the physical layer, handles all **radio-specific** functions.
- The physical layer at Um uses GMSK for digital modulation and performs **encryption/decryption** of data, i.e., encryption is not performed end-to-end, but only between MS and BSS over the air interface.
- **Synchronization** also includes the correction of the individual path delay between an MS and the BTS.
- All MSs within a cell use the same BTS and thus must be synchronized to this BTS.
- The BTS generates the **time-structure** of frames, slots etc.
- A problematic aspect in this context are the different **round trip times** (RTT).
- The main tasks of the physical layer comprise channel **coding** and **error detection/correction**, which is directly combined with the coding mechanisms.
- Channel coding makes extensive use of different **forward error correction** (FEC) schemes.
- The power of an FEC scheme depends on the amount of **redundancy, coding algorithm** and further interleaving of data to minimize the effects of burst errors.

GSM -Protocols

- Signaling between entities in a GSM network requires higher layers.
- For this purpose, the LAPDm protocol has been defined at the Um interface for layer two.
- LAPDm, as the name already implies, has been derived from **link access procedure for the D-channel** (LAPD) in ISDN systems, which is a version of HDLC.
- LAPDm is a lightweight LAPD because it does not need synchronization flags or check summing for error detection.
- LAPDm offers

- reliable data transfer over connections

- re-sequencing of data frames, and

- flow control.

- As there is no buffering between layer one and two, LAPDm has to obey the frame structures, recurrence patterns etc. defined for the Um interface.
- Further services provided by LAPDm include

- segmentation

- reassembly of data and

- acknowledged/unacknowledged data transfer.

GSM -Protocols

- The network layer in GSM, layer three, comprises several sub layers.
- The lowest sub layer is the **radio resource management** (RR).
- Only a part of this layer, RR', is implemented in the BTS, the remainder is situated in the BSC.
- The functions of RR' are supported by the BSC via the BTS management (BTSM).
- The main tasks of RR are

- Setup

- maintenance, and

- release of radio channels.

- RR also directly accesses the physical layer for **radio information** and offers a **reliable** connection to the next higher layer.

GSM -Protocols

- **Mobility management** (MM) contains functions for

- registration,

- authentication,

- identification,

- location updating, and

- the provision of a temporary mobile subscriber identity (TMSI) that replaces the international mobile subscriber identity (IMSI) and which hides the real identity of an MS user over the air interface.

- While the IMSI identifies a user, the TMSI is valid only in the current location area of a VLR.

- MM offers a **reliable connection** to the next higher layer.

- **call management** (CM) layer contains three entities:

- call control (CC),

- short message service (SMS), and

- supplementary service (SS).

GSM -Protocols

- SMS allows for message transfer using the control channels SDCCH and SACCH.
- CC provides a point-to-point connection between two terminals and is used by higher layers for **call establishment, call clearing** and **change of call parameters.**
- This layer also provides functions to send **in-band tones**, called **dual tone multiple frequency** (DTMF), over the GSM network.
- These tones are used, e.g., for the remote control of answering machines or the entry of PINs in electronic banking and are, also used for dialing in traditional analog telephone systems.
- Additional protocols are used at the Abis and A interfaces.
- **Signaling system No. 7** (SS7) is used for signaling between an MSC and a BSC.
- This protocol also transfers all management information between MSCs, HLR, VLRs, AuC, EIR, and OMC.

GSM –Localization and Calling

- One fundamental feature of the GSM system is the automatic, **worldwide localization** of users.
- To provide this service, GSM performs **periodic location updates** even if a user does not use the mobile station.
- The HLR always contains information about the current location, and the VLR currently responsible for the MS informs the HLR about location changes.
- As soon as an MS moves into the range of a new VLR, the HLR sends all user data needed to the new VLR.
- Changing VLRs with uninterrupted availability of all services is also called **roaming**.
- Roaming can take place within the network of one provider, between two providers in one country, but also between different providers in different countries.
- To locate a MS and to address the MS, several numbers are needed:

- Mobile station international ISDN number (MSISDN):

- This number consists of the **country code** (CC) (e.g., +49 179 1234567 with 49 for Germany), the **national destination code** (NDC) (i.e., the address of the network provider, e.g., 179), and the **subscriber number** (SN).

GSM –Localization and Calling

- **International mobile subscriber identity (IMSI):**

• GSM uses the IMSI for internal **unique identification** of a subscriber.

• IMSI consists of a **mobile country code** (MCC)(e.g., 240 for Sweden, 208 for France), the **mobile network code** (MNC)(i.e., the code of the network provider), and finally the **mobile subscriber identification number** (MSIN).

- **Temporary mobile subscriber identity (TMSI):**

• To hide the IMSI, which would give away the exact identity of the user signaling over the air interface, GSM uses the 4 byte TMSI for local subscriber identification.

• TMSI is selected by the current VLR and is only valid temporarily and within the location area of the VLR

- **Mobile station roaming number (MSRN):**

• Another temporary address that hides the identity and location of a subscriber is MSRN.

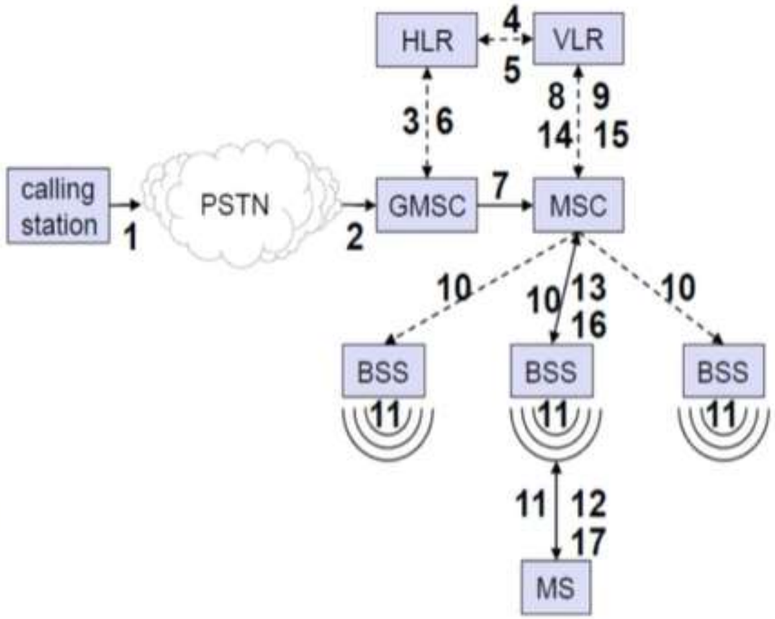
• The VLR generates this address on request from the MSC, and the address is also stored in the HLR.

• MSRN contains the **current visitor country code** (VCC), the **visitor national destination code** (VNDC), the identification of the current MSC together with the subscriber number.

• The MSRN helps the HLR to find a subscriber for an incoming call.

GSM –Localization and Calling

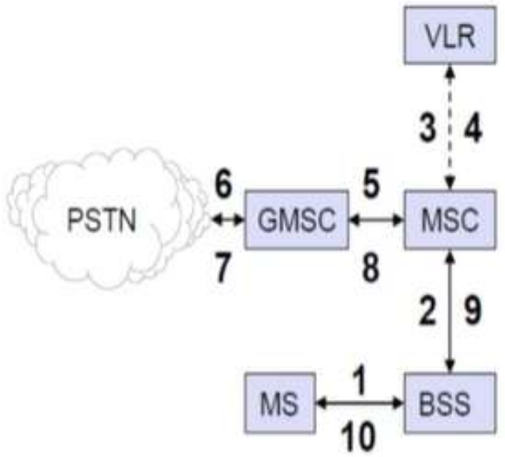
- 1: calling a GSM subscriber
- 2: forwarding call to GMSC
- 3: signal call setup to HLR
- 4, 5: request MSRN from VLR
- 6: forward responsible MSC to GMSC
- 7: forward call to current MSC
- 8, 9: get current status of MS
- 10, 11: paging of MS
- 12, 13: MS answers
- 14, 15: security checks
- 16, 17: set up connection



Mobile terminated call (MTC)

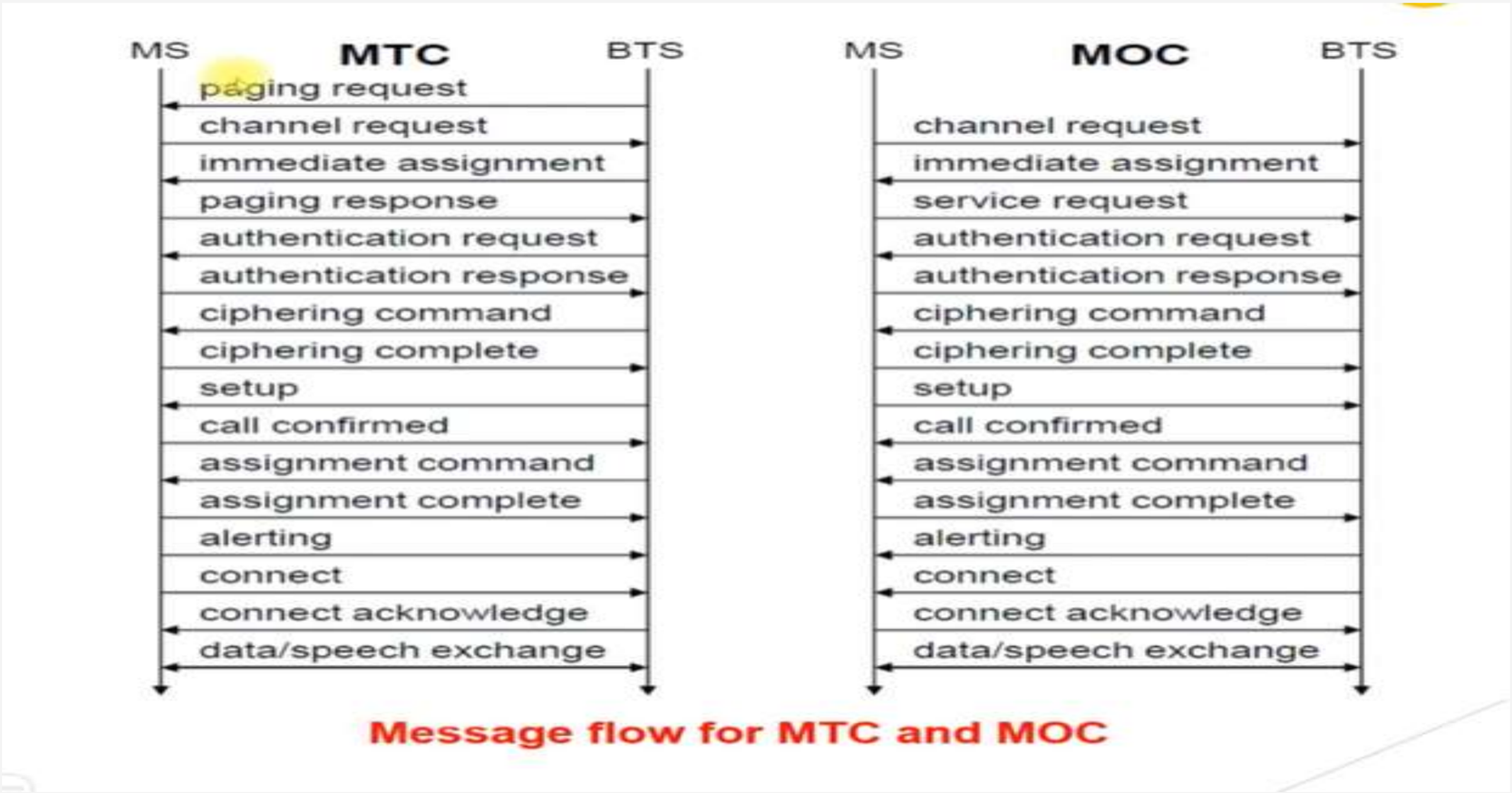
GSM –Localization and Calling

- 1, 2: connection request
- 3, 4: security check
- 5-8: check resources (free circuit)
- 9-10: set up call



Mobile originated call (MOC)

GSM –Localization and Calling



Message flow for MTC and MOC

GSM –Handover

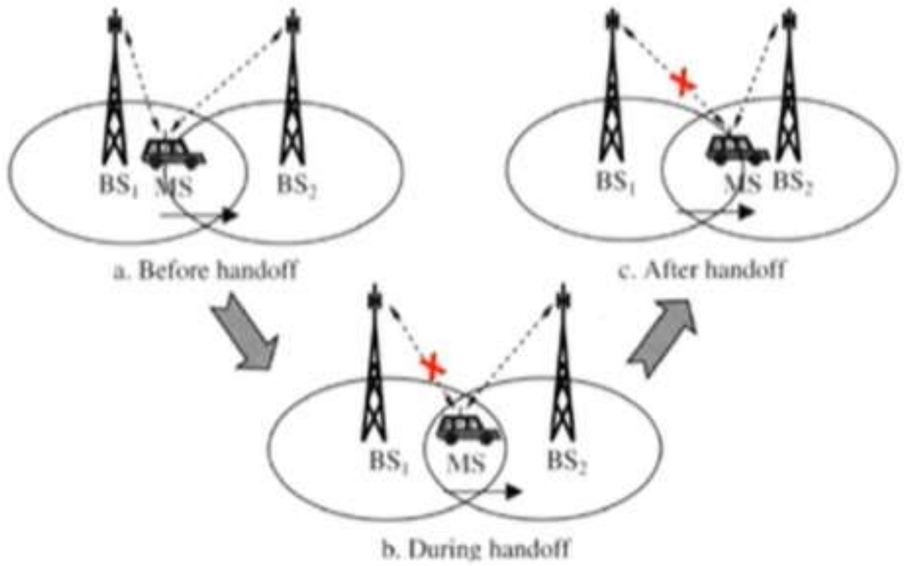
- Cellular systems require handover procedures, as single cells do not cover the whole service area, but, e.g., only up to 35 km around each antenna on the countryside and some hundred meters in cities.
- The smaller the cell size and the faster the movement of a mobile station through the cells (up to 250 km/h for GSM), the more handovers of ongoing calls are required.
- However, a handover should not cause a **cut-off**, also called **call drop**.
- GSM aims at maximum handover duration of 60 ms.

There are two basic reasons for a handover.

1. The mobile station moves out of the range of a BTS or a certain antenna of a BTS respectively.
2. Handover may be due to load balancing.

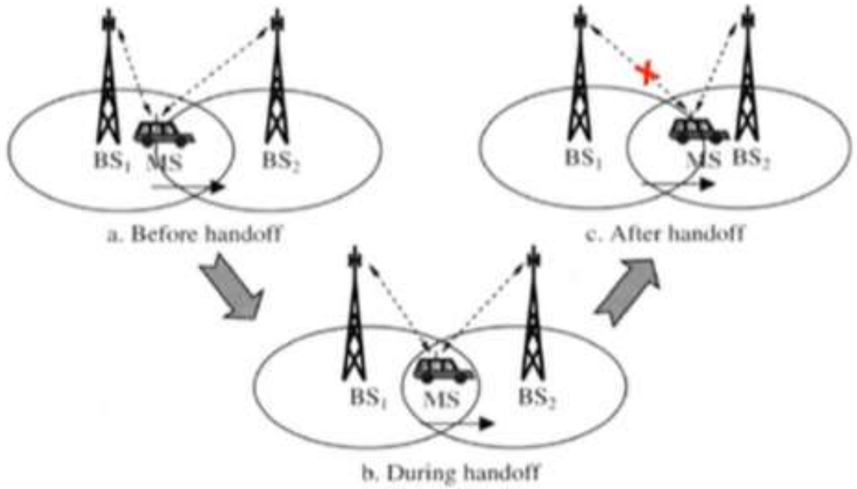
GSM –Handover

Hard handover - The connection to the source is broken before or 'as' the connection to the target is made—for this reason such handovers are also known as *break-before-make*.



GSM –Handover

Soft handover - The connection to the target is established before the connection to the source is broken, hence this handover is called *make-before-break*.



GSM –Handover

- Four possible handover scenarios in GSM:
- **Intra-cell handover:**

- Within a cell, narrow-band interference could make transmission at a certain frequency impossible.

- The BSC could then decide to change the carrier frequency.

- **Inter-cell, intra-BSC handover:**

- The mobile station moves from one cell to another, but stays within the control of the same BSC.

- The BSC then performs a handover, assigns a new radio channel in the new cell and releases the old one.

- **Inter-BSC, intra-MSC handover:**

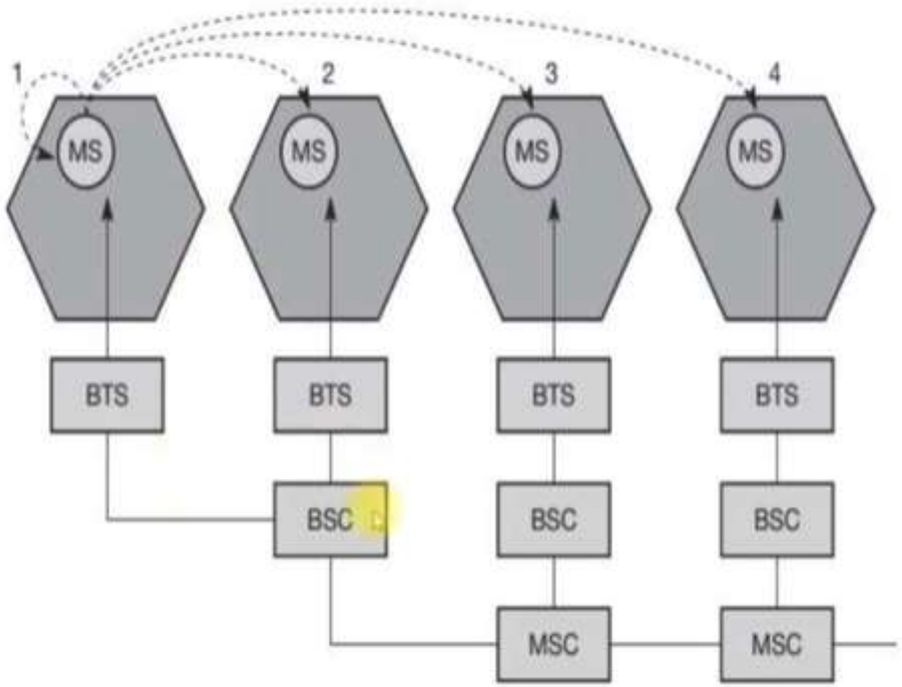
- As a BSC only controls a limited number of cells; GSM also has to perform handovers between cells controlled by different BSCs. This handover then has to be controlled by the MSC.

- **Inter MSC handover:**

- A handover could be required between two cells belonging to different MSCs.

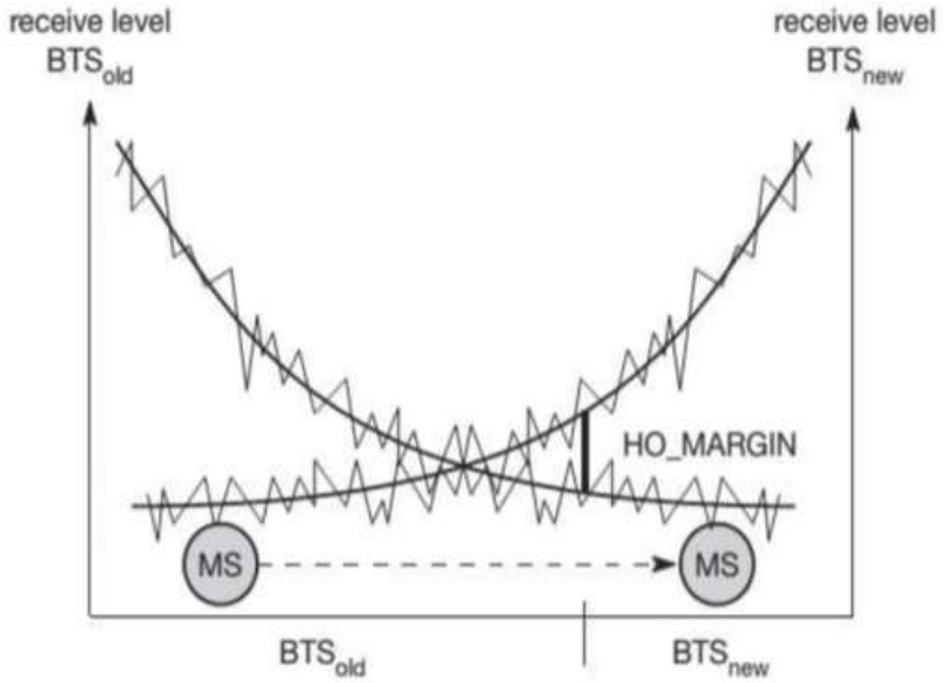
- Now both MSCs perform the handover together.

GSM –Handover



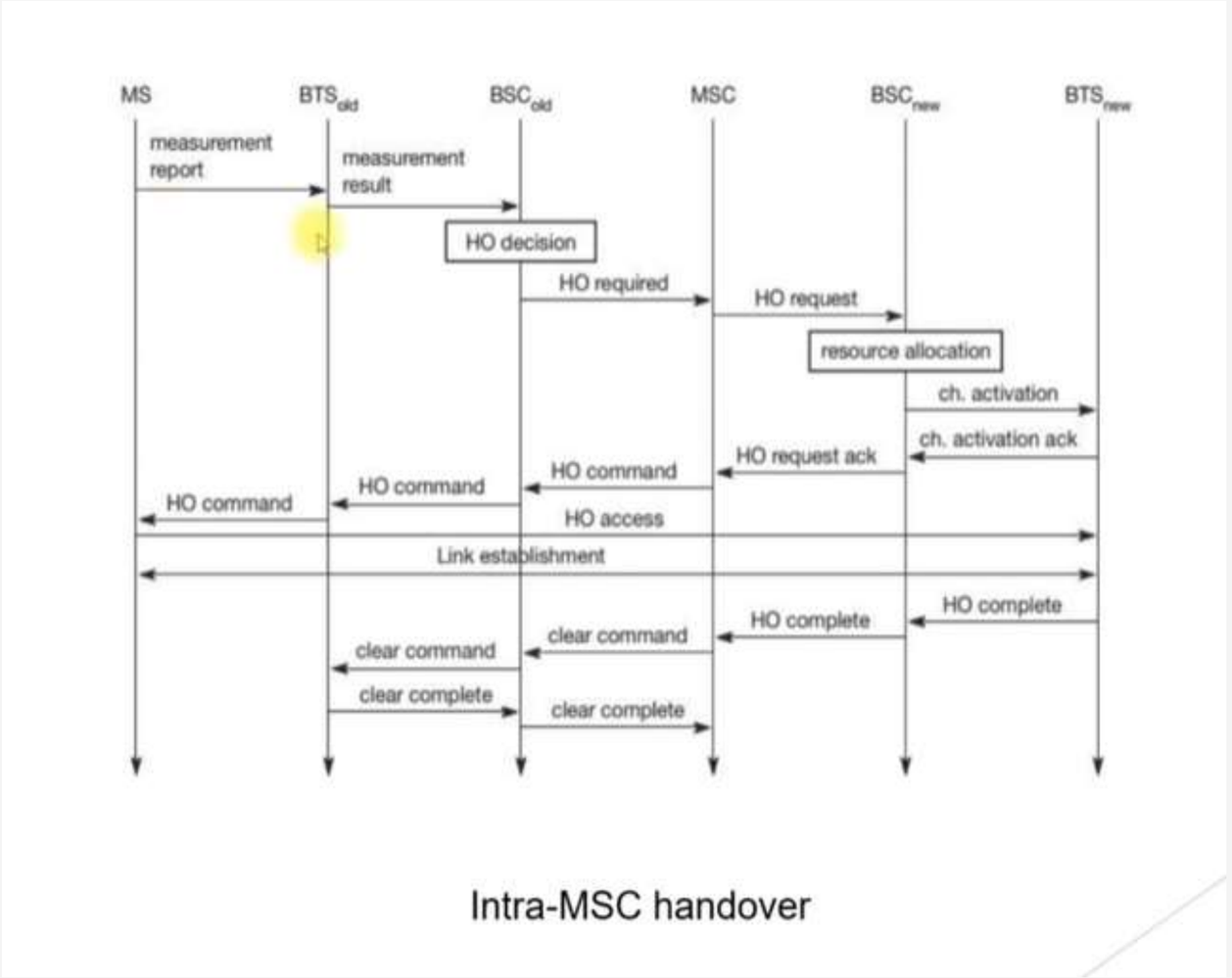
Types of handover
in GSM

GSM –Handover



Handover decision depending on receive level

GSM –Handover



Intra-MSC handover

GSM –Security

- GSM offers several security services using confidential information stored in the AuC and in the individual SIM.
- The SIM stores personal, secret data and is protected with a PIN against unauthorized use.
- The security services offered by GSM are

- Access control and authentication:

- The first step includes the authentication of a valid user for the SIM.
- The user needs a secret PIN to access the SIM.
- The next step is the subscriber authentication.
- This step is based on a challenge-response scheme

- Confidentiality:

- All user-related data is encrypted.
- After authentication, BTS and MS apply encryption to voice, data, and signaling.
- This confidentiality exists only between MS and BTS, but it does not exist end-to-end or within the whole fixed GSM/telephone network.

GSM –Security

- **Anonymity:**

• To provide user anonymity, all data is encrypted before transmission, and user identifiers (which would reveal an identity) are not used over the air.

• Instead, GSM transmits a temporary identifier (TMSI), which is newly assigned by the VLR after each location update.

• Additionally, the VLR can change the TMSI at any time.

• Three algorithms have been specified to provide security services in GSM.

• Algorithm **A3** is used for authentication, **A5** for encryption, and **A8** for the generation of a cipher key.

Authentication

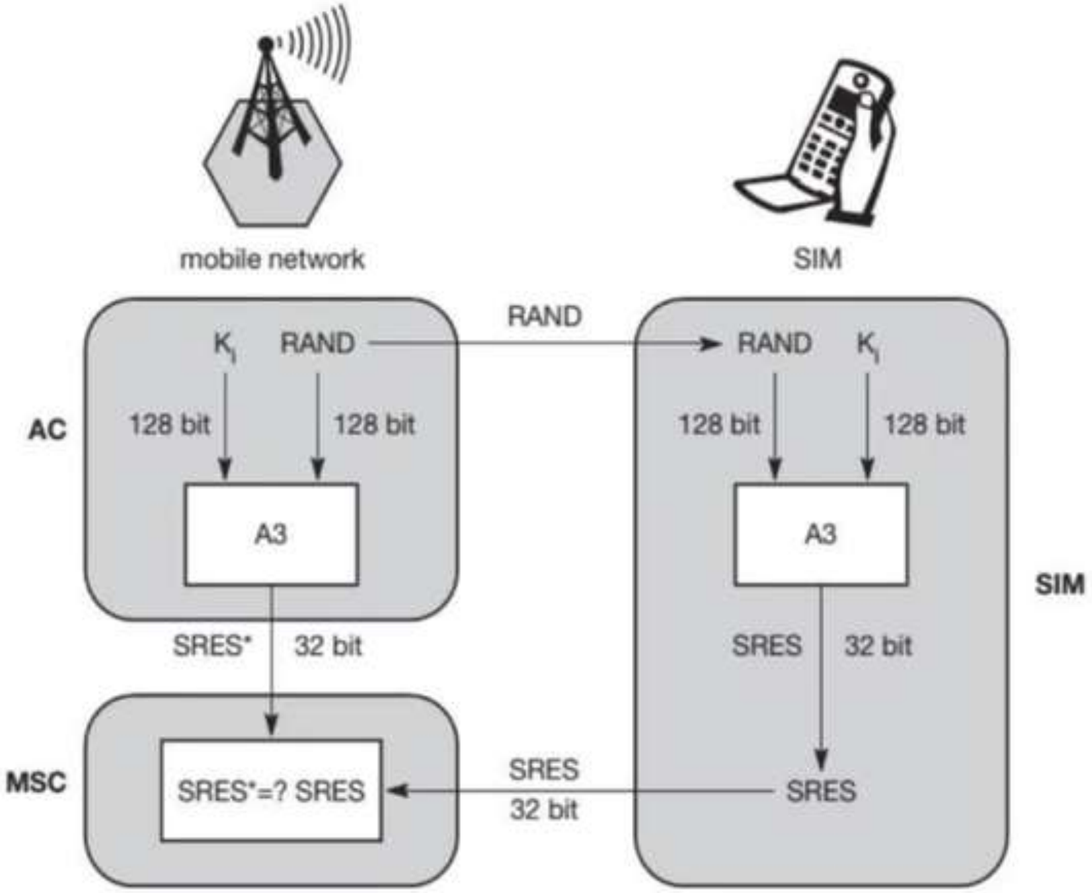
• Before a subscriber can use any service from the GSM network, he or she must be authenticated.

• Authentication is based on the SIM, which stores the individual authentication key Ki, the user identification IMSI, and the algorithm used for authentication A3.

• Authentication uses a challenge-response method:

- The **access control** AC generates a random number RAND as challenge, and the SIM within the MS answers with SRES (signed response) as response.

GSM –Security



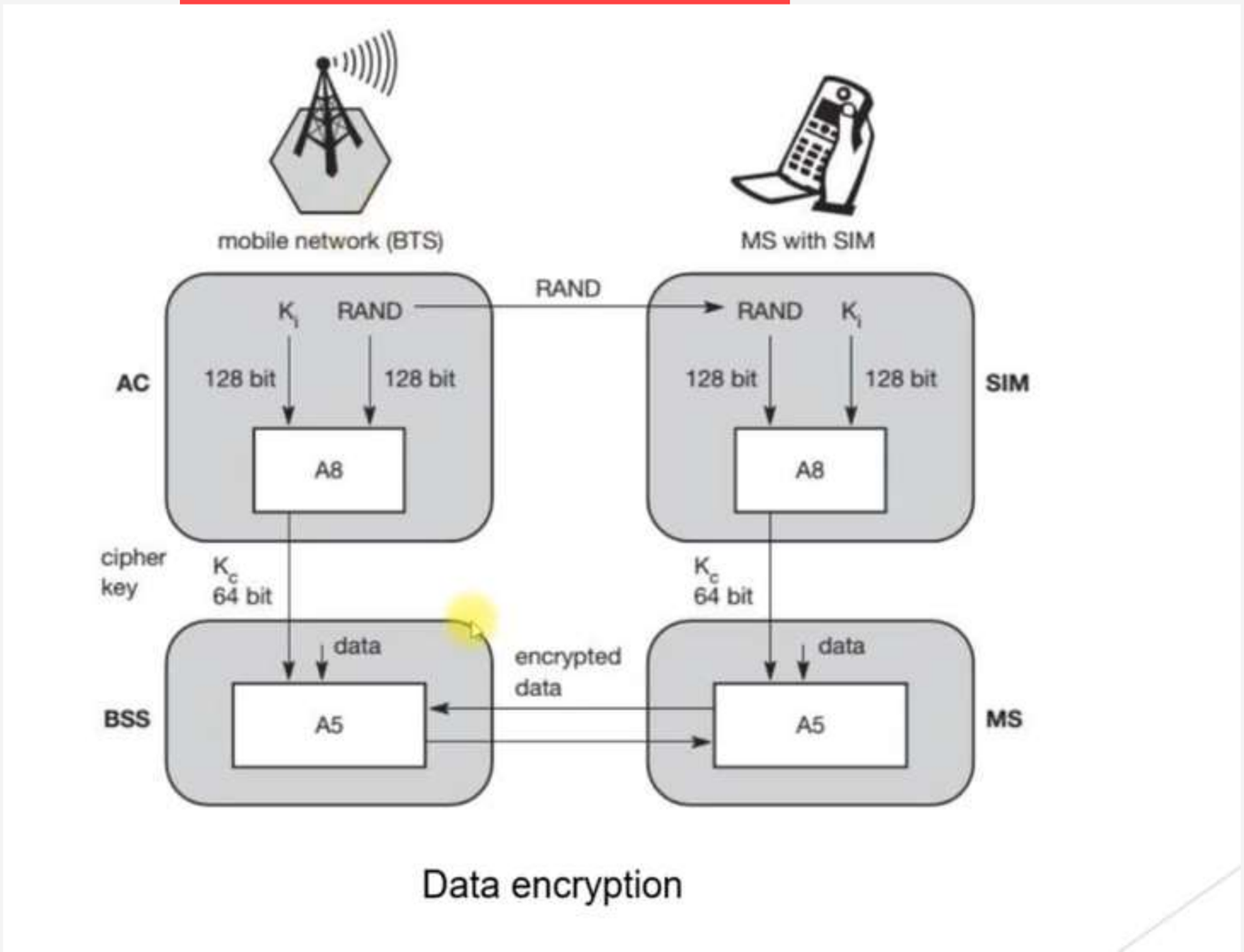
Subscriber authentication

GSM –Security

Encryption

- To ensure privacy, all messages containing user-related information are encrypted in GSM over the air interface.
- After authentication, MS and BSS can start using encryption by applying the cipher key Kc.
- Kc is generated using the individual key Ki and a random value by applying the algorithm A8.
- Note that the SIM in the MS and the network both calculate the same Kc based on the random value RAND.
- The key Kc itself is not transmitted over the air interface.
- MS and BTS can now encrypt and decrypt data using the algorithm A5 and the cipher key Kc.

GSM –Security



GPRS

- General Packet Radio Services (GPRS) is **a best-effort packet-switching protocol for wireless and cellular network communication services**. It is considered best effort because all packets are given the same priority and the delivery of packets is not guaranteed.

- General packet radio service (GPRS) is essentially **a packet-switching technology that allows information to be transmitted via mobile networks**. This is utilized for internet connectivity, multimedia messaging service, and other types of data transmission.

- GPRS is used in mobile phones for Data communication. It is an acronym for General Packet Radio Services (GPRS). It is a packet-based wireless communication service.

- GPRS is **a wireless extension of data networks**. It can access to data networks, such as IP-based networks (public internet, private intranet, IPv4 and IPv6 protocols) and X. 25 based networks.

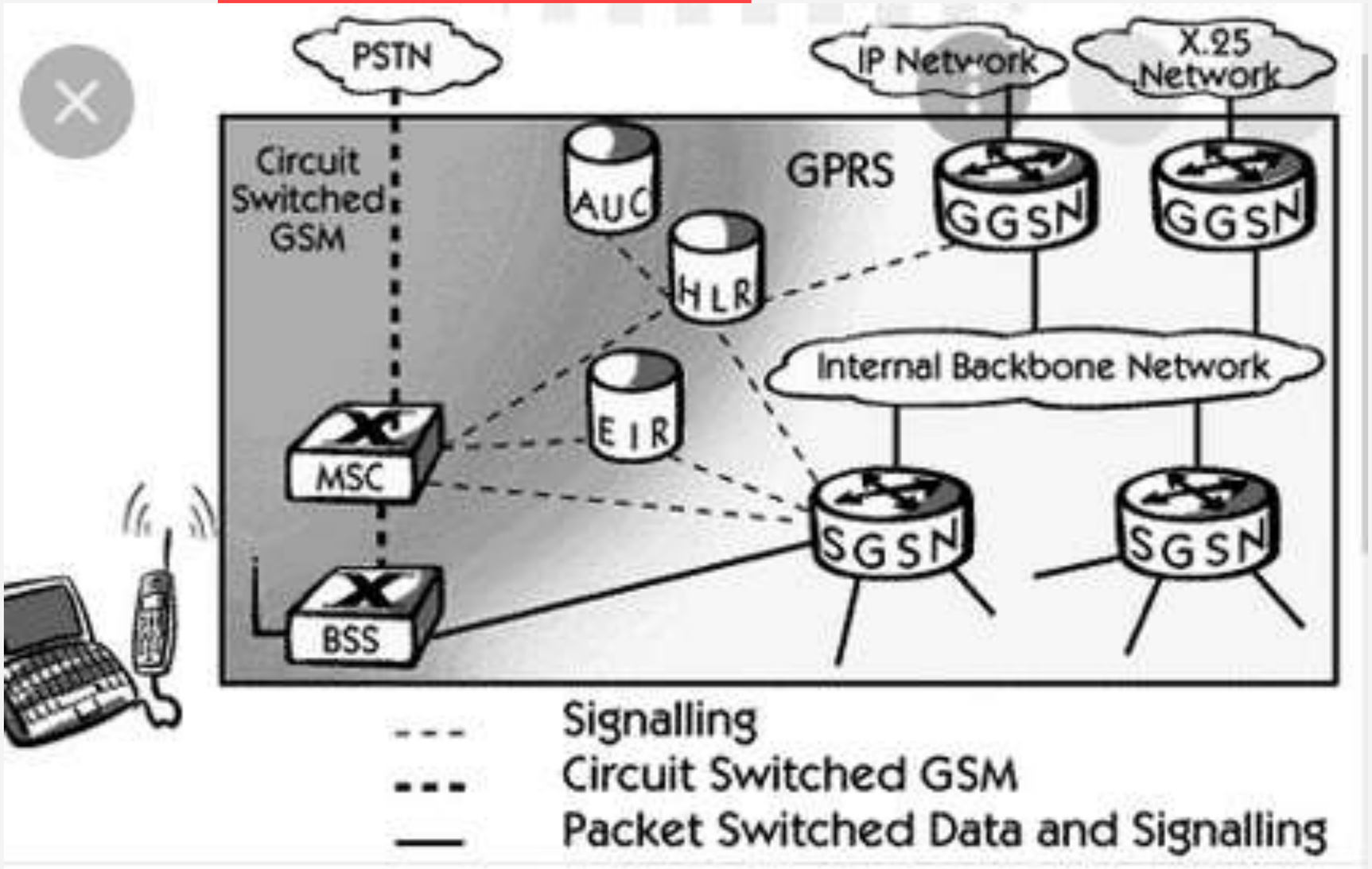
Applications of GPRS

- SMS messaging and broadcasting.
- "Always on" internet access.
- Multimedia messaging service (MMS)
- Push-to-talk over cellular (PoC)
- Instant messaging and presence—wireless village.

Types of GPRS

- **Point-to-point (PTP)**
- **Point-to-multipoint (PTM)**

Architecture of GPRS



Components of GPRS

Refer Components of GPRS in the below link

https://www.tutorialspoint.com/gprs/gprs_architecture.htm

UMTS

- The Universal Mobile Telecommunications System (UMTS) is a broadband, packet-based, 3G mobile cellular system based upon GSM standards. The specifications of UMTS covers the entire network system, including the radio access network, the core network and user authentication.

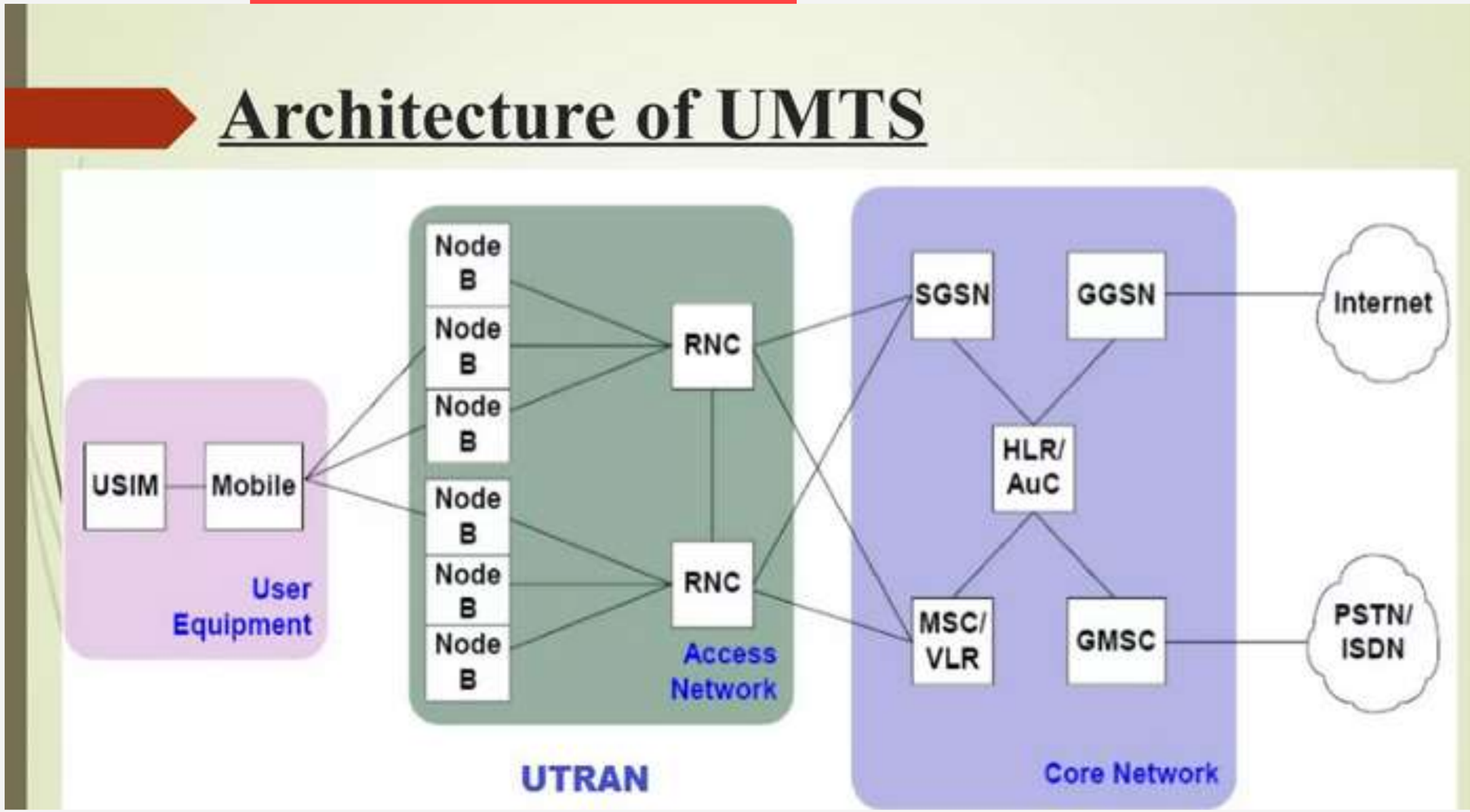
Features

- UMTS is a component of IMT-2000 standard of the International Telecommunications Union (ITU), developed by 3GPP.
- It uses wideband code division multiple access (W-CDMA) air interface.
- It provides transmission of text, digitized voice, video and multimedia.
- It provides high bandwidth to mobile operators.
- It gives a high data rate of 2Mbps. For High-Speed Downlink Packet Access (HSDPA) handsets, the data-rate is as high as 7.2 Mbps in the downlink connection.
- It is also known as Freedom of Mobile Multimedia Access (FOMA).
- It encompasses specifications for the entire mobile network system −
  - Radio access network specified by UTRAN (UMTS Terrestrial Radio Access Network)
  - Core network specified by MAP (Mobile Application Part)
  - Authentication of the users by SIM (Subscriber Identity Module) cards.

Applications

- Streaming / Download (Video, Audio)
- Videoconferences.
- Fast Internet / Intranet.
- Mobile E-Commerce (M-Commerce)
- Remote Login
- Background Class applications
- Multimedia-Messaging, E-Mail
- FTP Access
- Mobile Entertainment (Games)

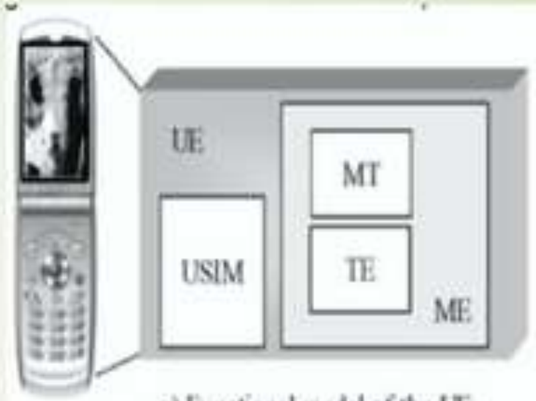
Architecture of UMTS



Architecture of UMTS

1- User Equipment:-

- It is not a simple mobile phone but rather, a mobile multimedia terminal provides simultaneously voice, video and data services.
- UE is composed of two parts
  - -Mobile Equipment(ME)
  - -Universal subscriber identity module (USIM).



a) Functional model of the UE

1.1 Mobile Equipment

- It performs reliable data and signalling message transfer throughout the radio Interface.
- User data is generated in uplink and processed in the downlink, Application protocols such as WAP/IP are located in the TE.

Architecture of UMTS

1.2 USIM

Information located in USIM are:

- The personal identification Number(PIN).
- The preferred languages
- The codes to enable emergency call
- One or several IMSI and MSISDN.
- The user's temporary identities allocated.
- Circuit and packet switched temporary location information.

Architecture of UMTS

2- UTRAN

- The UMTS(UMTS Terrestrial Radio Access network) has two elements:
  - RNC
  - Node B.
- UTRAN is subdivided into individual radio network (RNS), where each RNS is controlled by RNC.
- The RNC is connected to a set of Node B elements, each of which can serve one or several cells.